A Human Capital-Based Theory of Post Marital Residence Rules

Matthew J. Baker
Department of Economics
United States Naval Academy
76 Nimitz Building
Annapolis, MD 21402
email: mbaker@usna.edu

and

Joyce P. Jacobsen
Department of Economics
Wesleyan University
222 Church Street
Middletown, CT 06459
email: jjacobsen@wesleyan.edu

July 15, 2005

We thank Nancy Folbre, Peter Kooreman, Gil Skillman, two anonymous referees, and session participants at the Society for Economic Anthropology meetings, and in seminars at University of Groningen, the US Naval Academy, and the University of Massachusetts-Amherst for valuable comments and suggestions, Peter Guth, Wei Kwan and Huan Yu for research assistance, and Wesleyan University for financial assistance.

Abstract

In pre-modern societies the residence of a newly-wedded couple is often decided by custom. While researchers have analyzed factors leading to particular post-marital residence patterns, no one has explained why a society should have a customary rule in the first place. Our theory stems from contracting problems created by the nature of pre-marriage human capital investments. We argue that a fixed post-marital residence rule may solve a hold-up problem by specifying marriage terms and limiting possibilities for renegotiation; the trade-off is the rule may prohibit beneficial renegotiation of post-marital location. We compare alternative residence rules (or lack thereof) under different degrees of location specificity of human capital and environmental uncertainty. We apply our theoretical results to Murdock's (1967) 862-society data set, augmented with climate data. We find some predictive ability in variables related to outside options, control over the environment, and potential degree of social control.

1 Introduction

Customary rules specifying the place of residence of newly formed families are a standard feature of most societies. Post-marital residence rules play a crucial role in determining the composition of a particular society, and also impact profoundly and correlate highly with the way people view their own descent.

Economists have recently turned their attention to systematic examination of the implications of customary rules related to marriage and property transfer (cf. Botticini and Siow 2002, Foster 1999, Rao 1993). However, they have not considered the adoption of the rule itself, but rather have taken the post-marital location rule as given and considered such variations in size of dowry and amount of investment in childrens' human capital as related to family income and other variables.

In contrast, there has been extensive research on post-marital residence in anthropology. Julian Steward (1955) and Elman Service (1962) were among the first to attempt explanation of post-marital residence patterns, both arguing that "patrilocal" residence, when newlyweds reside with the husband's family, was prominent among hunter-gatherers because it was the naturally superior arrangement. Men were endowed with a natural dominance in productive tasks such as hunting, and engaging in warfare; those tasks that required a level of camaraderie and cooperation that could only be achieved through stable band composition. Many societies, however, did not follow the patrilocal pattern, a phenomenon that Service in particular attributed to contact with the West. Contact with the West brought new occupational alternatives or increased frequency of warfare, which altered the traditional need for relationships between males. Thus, he reasoned, in areas with a high degree of western contact, matrilocality (where newlyweds live with the wife's family) or bilocality (where newlyweds live with either family) became more likely to be observed.

The "Man the Hunter" conference (Lee and Devore, 1968) in the 1960s changed this view. Kelly (1995, p. 270) writes: "A new model developed. . . that emphasized bilateral descent and bilocal residence." The new model cast fluid and adaptive residence rules as advantageous because they allowed adaptation to environmental conditions. Subsequent studies among hunter-gatherers verified that while a majority of their societies were in fact patrilocal, a substantial portion of societies followed alternative residence patterns (cf. Ember 1978, Martin and Voorhees 1975). In particular, a number of societies featured matrilocal post-marital residence rules.

There are also a number of alternatives that occur less frequently. For instance,

the rule may specify residence with relatives on the husband or wife's side, but not necessarily the parents. In the empirical part of this paper, we draw upon Murdock's (1967) widely-used ethnographic database (which form a small subset of the data contained in the Human Relations Area Files ethnographic data collection housed at Yale), in which he and his colleagues read through ethnographic reports for a large number of societies (the vast majority of which are premodern in the sense of being nonindustrial) and coded numerous patterns, including marital residence patterns.

Table 1 describes the types of residence patterns found in these data and shows the proportion of societies displaying each type of residence pattern for this set of 862 societies. About 74 percent of the societies in the data set are patrilocal in the broader sense of couples living with members of the husband's family. 13 percent are matrilocal in the broader sense of couples living with members of the wife's family. 8 percent are bilocal in the sense that couples routinely live with relatives, but the side of the family varies. Almost 5 percent are neolocal, in that the spouses form a new household apart from either set of relatives, and potentially not even in their geographic vicinity. Finally, in a small number of societies, spouses do not form a common household.[1]

Ember and Ember (1971) number among the first to study systematically the forces leading to patrilocal or matrilocal residence patterns. Using two-way tables, they test the impact of the sexual division of labor, the relative status of the sexes, and presence of warfare on post-marital residence patterns. Using a subset of Murdock's data, they find little evidence for the commonly-held belief (c.f. Murdock 1949, Driver and Massey 1957) that the division of labor systematically impacts post-marital residence location, favoring instead the explanation that societies experiencing high degrees of internal warfare favor patrilocal residence for loyalty-related reasons.

Little systematic empirical work appears to have occurred in this area subsequent to Ember and Ember's work. Indeed, cross-cultural empiricism of the type championed by Murdock and his cohorts has fallen out of fashion in anthropology.[2] In addition, much research in this area is basically of the two-way nature (see Textor 1967 for the epitome of this line of research) rather than allowing for more complicated interconnections and multiple causal factors.

Thus, while previous research has made progress in isolating potential determinants of post-marital residence patterns, it has not addressed the need for or role of well-defined social rules governing marriage and residence. Specifically, explaining why newlyweds typically reside with the family of the husband is one thing; explaining why there is a fixed social rule requiring newlyweds to reside with the

husband's family is something quite different. However, it would be important to try to explain both empirical regularities: that of adoption of a fixed rule, and that of commonly choosing the particular fixed rule of patrilocality.

Our approach attempts to explain the forces leading to adoption of rules, rather than simply explaining tendencies. The need for rules dictating and describing the terms of marriage arises because families must decide on the amount of human capital to pass to their children well before the actual date of marriage. The most crucial aspect of a rigid social rule is that it prohibits negotiation of the terms of marriage (the marriage contract) at the date of marriage after human capital has been accumulated. As is well known, the possibility of negotiation at the date on which a contract is to be executed can critically undermine the usefulness of the contract.[3] When parties to a contract foresee the possibility of renegotiation at the date of exchange, the potential for an underinvestment effect, commonly referred to as the hold-up problem, arises. The effect emerges because parties anticipate their inability to capture the complete returns to their investments through bargaining at the transaction date. However, a fixed residence rule, along with associated transfers between the families of the bride and husband, is an arrangement guided by force of custom. As such, families cannot negotiate the marriage arrangement without suffering the consequences of violating custom. Since parties know that the marriage arrangement will not be renegotiated at the date of marriage, the arrangement can mitigate the hold-up problem. In short, we adopt a view of customs dictating post marital residence as renegotiation-proof contracts.

In our model there is a cost to the rigidity of the marriage custom. A marriage custom must specify beforehand contractual terms that limit the potential of negotiation to gain any unexpected surplus that may be present at the marriage date; for instance, through disallowing choice of location. But the lack of a rule, while allowing flexibility, may reduce investment incentives because negotiation at the date of marriage is necessarily involved. The essential trade-off involved in imposition of a marriage custom is thus the costs of ex-post (as of marriage date) rigidity, weighed against ex-ante (before marriage) human capital investment incentives.

In the next section, we present our theoretical model of post-marital residence rule choice. In Section 3 we explore some of the implications stemming from this model using Murdock's cross-cultural data set, which we have supplemented with additional information. Section 4 discusses the loose ends in our results and considers how to extend this research program.

2 A Model of Post Marital Residence Rules

The model illustrates the possible benefits of a fixed marriage residence rule when human capital investments are made prior to marriage. The model allows us to address several questions, such as: What sort of residence rule is best, given the technological state of knowledge and environmental conditions of a particular society? What sort of compensation schemes between wives and husbands' families might coexist with residence rules?[4] Why should societies restrict the location and choices of newly formed families? Why not leave residence decisions to new families or postpone them until the date of marriage?

We view marriage as the combination of two distinct yet complementary pieces of human capital. Human capital must be developed prior to marriage and the process of developing the human capital of potential marriage partners requires costly effort. The burden of human capital formation in large part falls upon the family and relations of husbands and wives from the time of their birth. Parents early on must decide which skills their children learn and how intensively they will learn them through tutoring them, monitoring their performance, and/or purchasing education services. If a newly-created family is viewed as a productive unit, the value of which depends upon the human capital investment decisions of both sets of parents prior to marriage, investment decisions made prior to marriage are greatly complicated from the perspective of the families. The human capital investments of potential wives' and husbands' families interact in determining the value of the new family, and the investments of the two families become interdependent.

Couched in these terms, there are two dimensions to the human capital investment and marriage problem: a hold-up problem due to the nature and timing of the human capital investment process, and a cooperative investment problem, due to the fact that the married family has a jointly dependent value.[5] Many potential remedies to the sorts of problems posed by this environment have been posed, including shifting control or property rights[6] and reliance on different types of legal rules.[7] We add the possibility that custom may be another means by which hold-up problems can be mitigated. That is, when investments are specific to a particular transaction, investment decisions are sensitive to the nature and degree of *ex post* bargaining (bargaining after the investments are made), and to the degree to which parties can *ex ante* commit to refrain from *ex post* bargaining. Our model exploits these sensitivities.

2.1 The model

We model human capital investment decisions as a two-stage, cooperative game played between two players, whom we refer to as H (the husband and/or husband's family) and W (the wife and/or wife's family). In the first stage of the game, H and W simultaneously choose human capital investment levels, which we refer to as h and w, respectively. In the second stage of the game, h and w are combined in a marriage according to a production function and payoffs are realized. We restrict our analysis to these two families, and do not consider any elaborate marriage search or matching procedure. The model is analogous to a case in which husbands and wives are randomly matched.[8]

Post-marital residence rules constrain the nature of this transaction between H and W. In our model, marriage customs constrain the marriage process by specifying beforehand two things:

1. The identity of the acquirer (either H or W), and:

2. A customary compensation schedule between H and W.

Thus, a marriage custom defines a contractual relationship between the two parties and constrains the behavior of the concerned parties. A matrilocal marriage rule, for example, specifies that the newly created family always resides with W, and also that W pays some customary compensation to H for this right. W becomes the residual claimant of the newly-formed family.

If the bargaining relationship were not constrained by some sort of marriage rule, there would be nothing stopping H and W from negotiating at marriage a new location to capture additional surplus unforeseen at the contract date. The result is that H and W would realize that any agreement they entered into at the marriage date is non-binding, and hence they would not heed it in choosing human capital investment. A customary arrangement, on the other hand, is a binding agreement, in that a third party (society at large) enforces breach of customs.

To the extent that it is reasonable to expect that social and cultural norms generally tend to evolve towards efficiency, we expect that our results will offer some insight into predicting tendencies in marriage customs across different societies.[9] To accomplish this, we introduce variables that capture a particular society's technology and environment across three dimensions. The three primary dimensions in which technology and environment vary are:

1. Marriage specificity of human capital investments.

2. Location specificity of human capital investments.

3. Magnitude of environmental uncertainty.

Marriage specificity determines the magnitude and importance of the hold-up problem. An example of marriage specific capital would be knowing your spouses likes and dislikes and learning how to cater to likes and avoid dislikes (e.g., knowing how to prepare a spouse's favorite dishes and avoiding cooking foods that they do not like). More generally, the ability to engage in child-rearing activities, agriculture, or hunting may only be fully realized in a marriage setting in which each marriage partner is fully able to specialize and employ his or her skills, as in Becker's (1991) influential theory of marriage. In situations in which human capital is relatively marriage-specific, the desirability of a restrictive body of marriage customs increases.

Location specificity primarily determines where the new couple should optimally reside; if the husband's human capital is relatively specific to the location of his family, it is likely better that he and his wife should reside there (and vice-versa). Examples of location-specific capital are knowing how best to farm a particular plot of land, how best to exploit seasonal game migration patterns, and knowing where the best fishing spot is in the area and how best to get fish from it. In the case of Indian agriculture, empirical work by Rosenzweig and Wolpin (1985) suggests that location-specific knowledge is important, particularly in responding to adverse weather shocks.

Environmental uncertainty can include variable weather conditions at each location both from year to year and within the year (variation in environmental conditions within the society's geographical range would relate to location specificity instead). Greater degrees of environmental uncertainty increases the possibility that there will be gains to flexibility and negotiation; when a high degree of demand uncertainty is present, we shall therefore expect the benefits to not having a fixed marriage custom to be large. What we have termed environmental uncertainty might also capture other unforeseen features of H's and W's demand for a new familial unit, such as localized demographic changes due to disease or warfare, for example.

Using h and w to represent the husband's and wife's human capital, the gross value of the marriage at H and W's location, respectively, is:

$$V^H = V^H(w, h; \tilde{\epsilon}_H) \quad \text{and} \quad V^W = V^W(w, h; \tilde{\epsilon}_W),$$

where $\tilde{\epsilon}_H, \tilde{\epsilon}_W$ are realizations of location specific random variables. The random variables $\tilde{\epsilon}_H, \tilde{\epsilon}_W$ are realized after human capital investments have been made, but

before the marriage has occurred. We assume that:

$$V_1 > 0, V_2 > 0, V_{11} < 0, V_{22} < 0, V_{12} > 0.$$

The need to make assumptions on the partial derivative with respect to the random variable shall be eliminated by ensuing assumptions. We parameterize the marriage specificity of investments by using outside marriage value. In the event that the parties are not married, accumulated human capital still has some value to both H and W. We represent this value by the functions

$$O^H(h; \phi_H, \tilde{\epsilon_H}) \quad \text{and} \quad O^W(w; \phi_W, \tilde{\epsilon_W}).$$

These two functions refer to the value of the husband's human capital and the value of the wife's human capital outside marriage, respectively, and shall serve as threat points in bargaining. The outside marriage value of human capital also depends on the realization of the location specific random variables. In both functions the parameter ϕ serves as shift parameters and are used in comparative static analysis. We assume that both functions are increasing in ϕ. A larger value of ϕ indicates that human capital is less specific to marriage. These functions need not take on purely positive values. It may be the case that an unmarried wife or husband has a negative value to his or her family (that is, is a burden and not an asset), even if a substantial human capital investment was made prior to marriage.

Throughout we assume that:

$$\text{Max}[V^H, V^W] > O^W + O^H. \tag{1}$$

Inequality (1) ensures that marriage generates surplus. To characterize the location-specificity of human capital investments, we introduce parameters into the value functions as follows:

$$V^H = V(\delta_W w, h; \tilde{\epsilon}_H) \quad \text{and} \quad V^W = V(w, \delta_H h; \tilde{\epsilon}_W).$$

The parameters δ_H and δ_W capture the proportion of the husband's human capital that is transferable to the wife's area, and the wife's human capital that is transferable to the husband's area, respectively. For example, if local knowledge of game distribution patterns plays a large role in the husband's production function, δ_H will be small; his human capital is relatively non-transportable. As δ_H and δ_W increase, human capital is relatively more transportable and less reliant on location. We assume that the random variables are multiplicatively separable; i. e.,

$$V^H(\delta_W w, h; \tilde{\epsilon}_H) = \tilde{\epsilon}_H V(\delta_W w, h) \quad \text{and} \quad V^W(w, \delta_H h; \tilde{\epsilon}_W) = \tilde{\epsilon}_W V(w, \delta_H h).$$

We also apply this assumption to the functions describing the value of human capital outside of marriage:

$$O^H(h;\phi_H,\tilde{\epsilon_H}) = \tilde{\epsilon_H} O^H(h;\phi_H), \qquad O^W(w;\phi_W,\tilde{\epsilon_W}) = \tilde{\epsilon_W} O^W(w;\phi_W).$$

We assume that there are only two states of nature; one favorable to H's area, and the other to W's area. With probability one-half, $\tilde{\epsilon}_H = \bar{\epsilon}, \tilde{\epsilon}_W = \underline{\epsilon}$, and with probability one-half, $\tilde{\epsilon}_W = \bar{\epsilon}, \tilde{\epsilon}_H = \underline{\varepsilon}$, where $\bar{\epsilon} > \underline{\epsilon}$, $E(\varepsilon) = 1$. For simplicity we make the standard assumption that the marginal costs of making human capital investments are constant, and we normalize these marginal costs to unity; therefore, the costs of making a human capital investment of magnitude h, for example, is simply given by h.

We now set up value functions for each type of post-marital residence rule, taking into account the incentives for human capital investment under each rule. A by-product of this exercise is that we also are able to predict the magnitude and direction of transfers (dowries, bride prices) that one may expect to coexist with rules. We begin by discussing the value of patrilocal residence rules and then discuss matrilocal rules. We then contrast these cases with choice (bilocality mainly, but also by extension neolocality).

2.2 Patrilocal rules

Under a patrilocal rule, newly married couples always reside with H and a customary transfer between H and W is made on the wedding day, and H becomes the residual claimant of the marriage's value. Given that this relationship has been specified by custom, the expected net returns to the marriage given residence with H are:

$$\pi^H(w,h) = E[\epsilon_H V(\delta_W w, h) - w - h] = V(\delta_W w, h) - w - h, \tag{2}$$

where ϵ_H takes on a value of $\bar{\epsilon}$ or $\underline{\epsilon}$, each with probability 1/2. Equation (2) is maximized at the human capital investment levels w^H, h^H that simultaneously solve the first order conditions:

$$\delta_W V_1(\delta_W w^H, h^H) - 1 = 0, \qquad V_2(\delta_W w^H, h^H) - 1 = 0. \tag{3}$$

These maximizing values can be achieved by a contract described in Moore and Repullo (1988) and Che and Hausch (1999). H pays W a bride price given by:

$$t_{HW} = V(\delta_W w, h) - V(\delta_W w^H, h) + T, \tag{4}$$

where T in (4) is a constant satisfying the participation constraints of both parties. The range for which T satisfies the participation constraints of both parties is described by the following condition:

$$O^W(\tilde{w}; \phi_W) - \tilde{w} + w^H \leq T \leq V(\delta_W w^H, h^H) - h^H - O^H(\tilde{h}; \phi_H) + \tilde{h}, \tag{5}$$

where

$$\tilde{w} = \arg\max_w \{O^W(\tilde{w}; \phi_W) - w\}, \qquad \tilde{h} = \arg\max_h \{O^H(\tilde{h}; \phi_H) - h\}. \tag{6}$$

The choices described by $\tilde{w}$ and $\tilde{h}$ maximize the expected value of human capital outside of marriage. To see that each party choosing w^H, h^H under the arrangement described by (4) is a Nash equilibrium, note that the wife's family chooses w to maximize:

$$t_{HW} - w = V(\delta_W w, h) - V(\delta_W w^H, h) + T - w.$$

Given that $h = h^H$, the first-order condition to this problem is:

$$\delta_W V_1(\delta_W w, h^H) - 1 = 0, \tag{7}$$

From (7), it follows that $w = w^H$, given that $h = h^H$. Similarly, as the acquirer of the new family in this case, the husband's family chooses h to maximize the expected value of the family, less the costs of acquiring the bride and the costs of human capital investment:

$$E[\epsilon_H V(\delta_W w, h) - t_{HW} - h] = V(\delta_W w^H, h) - T - h. \tag{8}$$

The first-order condition to problem (8) is:

$$V_2(\delta_W w^H, h) - 1 = 0, \tag{9}$$

so $h = h^H$ given $w = w^H$. Equations (7) and (9) together show that $w = w^H$ and $h = h^H$ are Nash equilibrium investments given the arrangement described by

(4). Plugging these optimizing values back into (2) gives a function $\pi^H(w^H, h^H)$ that denotes returns under the patrilocal rule, where human capital investments are chosen according to (3).

Critically, the agreement must be thought to be binding by both parties at the time investments are made. If either party perceives that this agreement could be renegotiated at the date of marriage, behavior changes, as they no longer anticipate the payoffs outlined by the contract given by (4). Further, by specifying the identity of the buyer, the contract has eliminated the possibility of capturing a surplus in a state of nature in which $\tilde{\epsilon}_W = \bar{\epsilon}, \tilde{\epsilon}_H = \underline{\epsilon}$; when the environment turns out to be relatively favorable in the wife's area and relatively unfavorable in the husband's area. In these situations, it may be preferable for the identity of the buyer to change to the wife, a possibility that is disallowed by the simple contract. While more complex marriage arrangements are certainly imaginable, some of which might allow the identity of the buyer to change according to the realizations of environmental variables, the simple contract described in conjunction with (4) has the advantage of simplicity, and only relies on information that is easily verified by "society at large." Thus, under the simple contract, society can easily ensure that both parties obey the terms of the contract, without having information about the state of nature in both parties location or random components of parties' valuation of the family.

The optimizing values w^H and $h^H$of the function $\pi^H(w^H, h^H)$ are functions of the parameter δ_W only. Thus, we may write:

$$w^H = w^H(\delta_W), \quad h^H = h^H(\delta_W).$$

Under plausible conditions both w^H and h^H are increasing in the parameter δ_W. Formally, the optimizing values are increasing in the parameter if:

$$-(V_1 + \delta_W w^H V_{11})V_{22} + V_{12} w^H \delta_W V_{21} > 0. \tag{10}$$

The second term is always positive, while the first term is negative so long as:

$$-\frac{V_{11}\delta_W w^H}{V_1} < 1. \tag{11}$$

(11) is a sufficient condition for both w^H and h^H to be increasing in δ_W, although optimizing values may still be increasing in δ_W even if (11) does not hold, as (10) may still be true. The condition essentially says that the elasticity of the slope of the joint-return function V, cannot be too large. Throughout we shall assume that condition (10) is satisfied.

Turning now to the size of the transfer t_{HW}, at w^H, h^H. Inspection of t_{HW} described in equation (4) reveals that at w^H, h^H the magnitude of the actual transfer from the husband's family to the wife's family depends on the size of T, which is not uniquely determined but may be chosen from a range of values to satisfy the participation constraints of both parties. A reasonable value for T is:

$$T = O^W(w^H; \phi_W) + \frac{1}{2}(V(\delta_W w^H, h^H) - O^H(h^H; \phi_H) - O^W(w^H; \phi_W)). \qquad (12)$$

In brackets on the right-hand side of (12) is the surplus created by marriage given that the new couple will live with the husband's family (compare (12) with (1)). This value splits the expected surplus created by marriage evenly between the parties, and is the Nash bargaining equilibrium division of the surplus. Substituting (12) into (4) gives:

$$\begin{aligned} t_{HW} &= V^H(w, h) - V^H(w^H, h) \\ &+ \tfrac{1}{2}\{V(\delta_W w^H, h^H) - O^H(h^H; \phi_H) + O^W(w^H; \phi_W)\}, \end{aligned} \qquad (13)$$

Since we have shown that the Nash equilibrium solution for w and h are $w = w^H$ and $h = h^H$, we can substitute these values into (13) to get:

$$t_{HW} = \frac{1}{2}\{V(\delta_W w^H, h^H) - O^H(h^H; \phi_H) + O^W(w^H; \phi_W)\}. \qquad (14)$$

A reasonable benchmark is that in equilibrium the size of the transfer depends on the size of the expected marriage surplus. Note that the transfer falls as the outside marriage value of the wife falls or the outside marriage value of the husband increases. It is also possible that a patrilocal marriage rule and a transfer from the wife's family to the husband's family could coexist. This occurrence is a special case of our model, which occurs when the wife's human capital has a sufficiently negative value when not married. From equation (14), if $O^H - V > O^W$, then the transfer is negative, implying that the wife's family compensates the husband's family for taking the bride. Therefore, one of the implications of our model is that dowry payments are more likely to be observed when the husband's human capital has a high value outside of marriage relative to its value in marriage, and the wife is a liability to her family if unmarried, in the sense that her human capital does not have a high value outside of marriage.

This result mirrors typical features of marriage transfers. For example, Boserup (1970) writes:

> In regions where women do most of the agricultural work it is the bridegroom who must pay bridewealth...but where women are less actively engaged in agriculture, marriage payments come usually from the girl's family. In South and East Asia the connection between the work of women and the direction of marriage payments is close and unmistakeable. In Burma, Malaya, and Laos women seem to do most of the agricultural work and bride prices are customary. (Boserup, 1970, p. 47)

The methodology underlying expression (14) may be used to describe a theory of dowry inflation complementary to that described by Anderson (2003). Anderson develops a theory that focuses on the interaction between increasing income dispersion caused by economic growth and the reliance on a caste system. One could also apply expression (14) to argue that technological progress coupled with a strong gender division of labor might also lead to dowry inflation. If there is a strong gender division of labor, as the process of economic growth continues, it is quite possible that O^H may grow faster than V^H, because as progress occurs the tasks that men perform within and outside of marriage converge, while O^W remains stagnant. This might happen, for example, if men, married or not, spend more of their time earning wages in a labor market. At the same time, the presence of a gender division of labor may prohibit women's outside marriage potential earnings from growing, so O^W may remain relatively constant. This combination of circumstances would allow for t_{HW} to grow more negative (assuming that $O^H - V > O^W$), indicating an increase in dowries.

Before continuing on, it is important to address an alternative contract form which could potentially describe the structure of transfers between the wife's and the husband's family.[10] Consider the marriage contract characterized by the equilibrium bride price:

$$t_{HW} = \frac{1}{2}\{\tilde{\epsilon}_H V(\delta_W w^H, h^H) - \tilde{\epsilon}_H O^H(h^H; \phi_H) + \tilde{\epsilon}_W O^W(w^H; \phi_W)\}. \tag{15}$$

The only difference between (15) and (14) is that the transfer described by (15) includes the random components of each return function, while (14) includes only the expectations. The arrangement described by (15) describes a contract that allows the families to share locational risk while ensuring that optimal human capital investments are made, in contrast to the contract described by (14), under which the husband's family bears all risk. From the perspective of society, however, the drawback to the risk-sharing arrangement is that it demands that society at

large know more about the situations of the two families than the contract which does not depend on random variables. We shall discuss this last question more fully when we compare the relative merits of different types of residence rules in section 2.5.

2.3 Matrilocal rules

Matrilocal rules follow essentially the same logic as patrilocal rules, except now custom ordains that newly married couples always reside with the wife's family, and the customary transfer is paid from the wife's family to the husband's family. Expected returns under the matrilocal residence rule are:

$$\pi^W(w,h) = E[\epsilon_W V(w, \delta_H h) - w - h] = V(w, \delta_H h) - w - h. \tag{16}$$

Expression (16) is maximized by values w^H, h^H that simultaneously solve the first order conditions:

$$V_1(w^W, \delta_H h^W) - 1 = 0, \qquad \delta_H V_2(w^W, \delta_H h^W) - 1 = 0.$$

The optimizing values w^W, h^W are functions of the parameter δ_H only. Thus, we can write:

$$w^W = w^W(\delta_H), h^W = h^W(\delta_H),$$

Under an appropriate condition like that described in (10) and (11), w^W and h^W are increasing in δ_H.

Again following Moore and Repullo (1988) and Che and Hausch (1999), the expected transfer from the wife's family to the husband's family that we expect to observe is given as:

$$t_{WH} = V^W(w, \delta_H h) - V^W(w, \delta_H h^W) + T,$$

where these terms are specified as of date one, and both parties know this contract is rendered nonnegotiable at the date of marriage by force of custom. As in the patrilocality case treated in section 2.2, a logical guide for the magnitude of the fixed component of the transfer is

$$T = O^H(h^W; \phi_W) + \frac{1}{2}(V(\delta_W w^H, h^H) - O^H(h^H; \phi_H) - O^W(w^H; \phi_W)). \quad (17)$$

The transfer can be negative, implying that the husband's family compensates the wife's family for taking the husband if the husband is a liability to his family if unmarried.

2.4 Choice (bilocality)

By giving families discretion over marriage location, society in effect has no body of marriage custom. Families can freely negotiate location (recall this amounts to negotiating the identity of the residual claimaint/buyer and seller in addition to compensation) and other marriage terms. The drawback is that families have no recourse to a third party to enforce any agreement made during stage one of the game, in contrast to the patrilocal and matrilocal cases. Lack of a body of marriage customs results in a lack of commitment power. To make our story more compelling, we assume that:

$$\begin{aligned} \bar{\epsilon} V^H(\delta_W w, h) &> \underline{\epsilon} V^W(w, \delta_H h), \\ \bar{\epsilon} V^W(w, \delta_H h) &> \underline{\epsilon} V^H(\delta_W w, h). \end{aligned} \quad (18)$$

One interpretation of (18) is that each of the two possible locations is *ex ante* potentially more desirable. If (18) did not hold, there would be no reason to allow choice, as one location would always be better. Hence, higher returns could always be achieved through a fixed rule.

The expected returns under choice are:

$$\pi^C(w, h) = \frac{1}{2}\bar{\epsilon}\{V^H(\delta_W w, h) + V^W(w, \delta_H h)\} - h - w. \quad (19)$$

Returns described in (19) captures the fact that families will always choose the location with the higher returns, in accordance with assumption (18), and thus always capture the random component of the surplus. Since any agreement made at stage one of the game is nonbinding, both parties foresee that the marriage returns will be divided between the buyer and seller according to some bargaining outcome at the date of marriage. We assume Nash bargaining, so that transfers are agreed upon so that the surplus is split evenly between the two families. Given

this bargaining solution, the wife's family expects to receive a net return from the marriage of:

$$O^W(w;\phi_W) + \frac{1}{2}[\frac{1}{2}\bar{\epsilon}(V^H(\delta_W w, h) + V^W(w, \delta_H h)) - O^H(h;\phi_H) - O^W(w;\phi_W)] - w. \tag{20}$$

The first part of (20) is the expected value of the wife's human capital outside marriage, which is also the wife's family's reservation payoff. The second part of (20) in brackets is one-half of the expected marriage surplus. The husband's family anticipates a return of:

$$O^H(h;\phi_h) + \frac{1}{2}[\frac{1}{2}\bar{\epsilon}(V^H(\delta_W w, h) + V^W(w, \delta_H h)) - O^H(h;\phi_H) - O^W(w;\phi_W)] - h. \tag{21}$$

The human capital investments w and h are chosen simultaneously by W and H, respectively, to maximize (20) and (21), respectively. We denote the Nash-equilibrium solutions to (20) and (21) for w and h as w^C and h^C, respectively. w^C and $h^C$are determined by the first-order conditions:[11]

$$\frac{1}{2}O_w^W + \frac{1}{2}\bar{\epsilon}[\frac{1}{2}\delta_W V_1^H + \frac{1}{2}V_1^W] - 1 = 0,$$

$$\frac{1}{2}O_h^H + \frac{1}{2}\bar{\epsilon}[\frac{1}{2}V_2^H + \frac{1}{2}\delta_H V_2^W] - 1 = 0, \tag{22}$$

The important thing about (22) is that, in contrast to the patrilocal case, in choosing w^C, h^C, both parties weight the expected outside marriage value of investments because they affect the share of surplus that shall eventually be obtained through bargaining. w^C, h^C depend on the entire set of parameters, also in contrast to patrilocality. That is:

$$w^C = w^C(\delta_H, \delta_W, \bar{\epsilon}, \phi_H, \phi_W),$$
$$h^C = h^C(\delta_H, \delta_W, \bar{\epsilon}, \phi_H, \phi_W).$$

So long as the second-order conditions associated with the first-order conditions given in (22) are satisfied, it can be shown that the optimizing values w^C and h^C are increasing in each parameter.[12] w^C and h^C increase as investments become

less location specific (as captured by an increase in δ) because there is a chance that the new family will reside in either area. Since both families take into account their effect on the marriage surplus, they increase investment. Higher uncertainty (as measured by the spread $\overline{\epsilon} - \underline{\epsilon}$) also increases the levels of investment, since both families realize that bargaining will allow the new family to be situated in the most favorable state. Thus, under locational choice, uncertainty increases the potential size of the surplus. Increases in the non-marriage values of investments (measured by ϕ) also increase human capital investments. This is because non-marriage values determine bargaining leverage and impact the expected share of the surplus.

As an aside, note that *neolocality*, where the couple may choose a residence location away from either family, should therefore increase the surplus's potential size yet more by allowing even more spread in the potential realizations of the random variables. For brevity, we do not model fully this choice in this paper; however note that such gains might potentially be offset by reduced output if separated from one's family (after all, it may be difficult to gauge what investment would be most useful in other settings). Another explanation for the apparent lack of popularity of neolocality among premodern societies might be the difficulty that families face in capturing the gains to the marriage if the married couple is not present in one or the other familial household. Of course, as it becomes easier to transmit wealth over distances, and as couples become less reliant on the rest of the family, one would expect an increasing incidence of neolocality, and neolocality and choice are certainly prevalent features of marriage in modern societies.

2.5 Comparative statics

We want to compare the relative values of the three alternative arrangements for varying parameter values. Before doing this, it is necessary to discuss an additional issue that we have so far remained silent on: the enforcement of post-marital residence rules. Like any set of rules, enforcing post-marital residence rules is likely a costly and imperfect endeavor. The costs of enforcing rules may depend on variables endogenous to our model, such as the magnitude of investments made by each parties, or our parameters measuring environmental variability, and may also depend on a variety of factors exogenous to our model, such as the distance between the parties or even the development and stratification of society. Of course, permitting residential choice then has the advantage that it does not carry the costs of enforcing rules (but still may carry some administrative costs; for example, enforcing any transfers that parties may agree on prior to marriage).

To keep things as simple as possible, but to also aid the reader in remembering that there are costs to enforcing rules, we include the costs of enforcing a rule when present are fixed and given by k when patrilocal or matrilocal rules are present, while they are zero when residence choice is allowed. In the empirical section of the paper, we describe some of the factors which are likely to make rules more costly to enforce.

To summarize our previous results, expected social returns under the patrilocal rule are:

$$\pi^H(w^H, h^H) - k^H = V(\delta_W w^H, h^H) - w^H - h^H - k^H \tag{23}$$

with

$$w^H = w^H(\delta_W), \qquad h^H = h^H(\delta_W),$$

where w^H and h^H are increasing in δ_w. Expected returns under the matrilocal rule are:

$$\pi^W(w^W, h^W) - k^W = V(w^W, \delta_H h^W) - w^W - h^W - k^W$$

with

$$w^W = w^W(\delta_H), \qquad h^W = h^W(\delta_H),$$

where w^W and h^W are increasing in δ_h. Expected returns under the bilocal rule are:

$$\pi^C(w^C, h^C) = \frac{1}{2}\bar{\epsilon}[V^H(\delta_W w^C, h^C) + V^W(w^C, \delta_H h^C)] - h^C - w^C$$

with

$$w^C = w^C(\delta_H, \delta_W, \bar{\epsilon}, \phi_H, \phi_W), \qquad h^C = h^C(\delta_H, \delta_W, \bar{\epsilon}, \phi_H, \phi_W),$$

where w^C and w^H are increasing in δ_H and δ_W, which measure the location specificity of investments; ϕ_W and ϕ_H, which reflect increasing non-marriage value of human capital, and $\bar{\epsilon}$, which measures the degree of variability in the value function. We begin by analyzing the comparative statics for ϕ_W and ϕ_H. From the above value functions it is clear that:

$$\frac{d\pi^H}{d\phi_H} = 0, \quad \frac{d\pi^H}{d\phi_W} = 0, \quad \frac{d\pi^W}{d\phi_H} = 0, \quad \frac{d\pi^W}{d\phi_W} = 0. \tag{24}$$

That is, changing the value of investments outside the marriage does not change the value of either the matrilocal or patrilocal rule (though it does change the division of the marriage surplus). However:

$$\frac{d\pi^C}{d\phi_H} = \frac{\partial \pi^C}{\partial w^C}\frac{\partial w^C}{\partial \phi_H} + \frac{\partial \pi^C}{\partial h^C}\frac{\partial h^C}{\partial \phi_H} > 0,$$
$$\frac{d\pi^C}{d\phi_W} = \frac{\partial \pi^C}{\partial w^C}\frac{\partial w^C}{\partial \phi_W} + \frac{\partial \pi^C}{\partial h^C}\frac{\partial h^C}{\partial \phi_W} > 0. \tag{25}$$

As the non-marriage value of human capital increases, so does the value of the bilocal rule. This is because H and W weight the non-marriage values of investments in their objective functions when deciding how much to invest. As the non-marriage values increase, so do the levels of human capital investment, which alleviates the under-investment effect caused in anticipation of *ex post* bargaining. Thus, it can be unambiguously said that larger non-marriage values increase the value of the bilocal (unrestricted) rule relative to either of the restricted (matrilocal or patrilocal) rules. Incidentally, this result may suggest one of the reasons why fixed residence rules are generally abandoned in more modern societies. Innovations such as labor markets greatly increase the value of human capital outside of marriage, making rules allowing choice more valuable relative to alternatives. This observation is an important feature of our empirical work in the next section.

A mean-preserving increase in uncertainty will also unambiguously increase the expected value of $\pi^C(w^C, h^C)$. If $\bar{\epsilon}$ and $\underline{\epsilon}$ are increased and decreased, respectively, by equal amounts, both $\pi^H(w^H, h^H)$ and $\pi^W(w^W, h^W)$ are unaffected. Note, however, that:

$$\frac{d\pi^C}{d(\bar{\epsilon} - \underline{\epsilon})} = \frac{1}{2}\{V^H(\delta_W w^C, h^C) + V^W(w^C, \delta_H h^C)\} + \frac{\partial \pi^C}{\partial w^C}\frac{\partial w^C}{\partial \bar{\epsilon}} + \frac{\partial \pi^C}{\partial h^C}\frac{\partial h^C}{\partial \bar{\epsilon}} > 0. \tag{26}$$

Equations (25) and (26) together imply that an increase in variability increases the value of π^C relative to π^H and π^W. Increases in uncertainty increase the value of allowing freedom of negotiation and *ex post* choice of location, because location choice allows the families to always capture the positive random component of the marriage surplus, while at the same time allowing families to avoid negative shocks to the marriage surplus that may occur in a particular area. Because expected returns are tied to the surplus created by marriage, and because a portion of this

surplus will be captured through negotiation, H and W also increase levels of human capital investment.

Finally, we turn to the comparative statics on δ_H; results are analogous for δ_W. We find that:

$$\frac{d\pi^H}{d\delta_H} = 0, \quad \frac{d\pi^W}{d\delta_H} = h^W V_2(w^W, \delta_H h^W) \geq 0,$$

and also that:

$$\frac{d\pi^C}{d\delta_H} = \frac{1}{2}\bar{\epsilon} h^C V_2^W + \frac{\partial \pi^C}{\partial w^C}\frac{\partial w^C}{\partial \delta_H} + \frac{\partial \pi^C}{\partial h^C}\frac{\partial h^C}{\partial \delta_H} > 0.$$

Thus, the value of choice relative to patrilocality increases as H's human capital investment grows more transportable. Alternatively, as the human capital investment of H becomes less transportable, the value of the patrilocal rule increases relative to the alternatives. The logic is the same regarding the wife's human capital: as human capital becomes more transportable, the value of the matrilocal rule decreases relative to the alternatives and vice versa. It is also evident that a change in enforcement costs, measured by the k term in the patrilocal and matrilocal expected social returns, also reduces the relative value of rules as compared to choice.

It is worthwhile to consider how robust these results are to more complex parameterizations of the problem. One generalization of the relationship between variability and location specificity, for example, is to allow for specificity to depend upon the realization of the random variable. It might be the case that favorable conditions in the husband's area also render the wife's human capital more transportable. One way of capturing this possibility is to assume that $\delta_i = \delta_i(\epsilon), \delta_i' > 0, i = H, W$. The fundamental change this causes in the optimization problem is that now both the marginal product of human capital and its overall value change with the realized state of the environment. By way of illustration, consider the patrilocal residence rule, and let $\overline{\delta}_W = \delta_W(\bar{\epsilon})$ and $\underline{\delta}_W = \delta_W(\underline{\epsilon})$. In contrast to the expected returns described by equation (23), we now have the following:

$$\pi^H - k^H = \frac{1}{2}\bar{\epsilon} V(\overline{\delta}_W w^H, h^H) + \frac{1}{2}\underline{\epsilon} V(\underline{\delta}_W w^H, h^H) - w^H - h^H - k^H \tag{27}$$

Expression (27) may be increasing as variability increases. Suppose that the function $\delta_i(\epsilon)$ is linear in ϵ so that increases in the spread of ϵ affect $\overline{\delta}_W$ and $\underline{\delta}_W$

proportionately. Then, increasing the value of $\overline{\epsilon}-\underline{\epsilon}$ generates a change proportional to the following expression (using, for example, $\overline{V}$ to denote $V(\overline{\delta}_W w^H, h^H)$:

$$\frac{1}{2}(\overline{V}-\underline{V})+\frac{1}{2}\delta' w^H(\overline{\epsilon}\overline{V}_1-\underline{\epsilon}\underline{V}_1) \tag{28}$$

The first term on the left-hand side above is strictly positive. This effect emerges because of the differences in the marginal products of investments across the two states. The second term on the left hand side is ambiguous in sign. While $\overline{\epsilon} > \underline{\epsilon}$ by assumption, by the concavity of the objective function, $\overline{V} < \underline{V}$. Only if the objective function is sufficiently concave is it likely that this expression is large enough to dominate and make (28) negative.

Note, however, that this extension increases the relative value of choice, as the ultimate value of choice depends only upon the nature of the environment in the high-return state. In this case, the concavity effect present in (28) is absent. This logic can also be applied in understanding how the optimizing decisions are affected. In terms of the optimal value of investments, the nature of the optimal values under choice described following equation (22) still hold; one must simply replace δ_i with $\overline{\delta}_i, i = W, H$. It is, however, no longer true that optimal values h^H, w^H and h^W, w^W are unaffected by increases in variability. The direction and magnitude of the change in these variables with respect to changes in variability depend upon how the effects described in reference to equation (28) play out.

To return to the discussion of the model, our results suggest the economic forces that may lead to social preference for fixed residence rules versus flexibility. If we suppose that there is a broad tendency for rules and customs to evolve towards more efficient outcomes over time, we can state the following:

1. *Fixed marital residence rules*: Fixed rules are more likely to occur when human capital is relatively location specific (either the husband or the wife's), uncertainty about the ex post best location for the newlyweds is low, and human capital is relatively specific to marriage.

2. *Choice*: Choice regarding place of residence is more likely to occur when human capital investments have a high value outside of marriage, uncertainty about the ex post location is high, and human capital is not very location specific.

3. *Selection of patrilocality or matrilocality as the fixed rule*: Patrilocality would be chosen as the fixed rule when the husband's human capital is relatively

location specific relative to the wife's; matrilocality when the wife's human capital is relatively location specific relative to the husband's.

4. *Magnitude and direction of transfers*: Transfers from H to W (i.e., a bride-price) will occur under patrilocality and should increase with the outside value of the wife's human capital and decrease the larger the outside value of the husband's human capital. If O^W is sufficiently negative, a transfer from W to H (i.e., a dowry) may be observed. The opposite transfer patterns will occur under matrilocality.[13] In either case, it is necessary that transfers be customary in the society in order for a fixed post-marital location rule to occur, because otherwise there will be no way of compensating for the human capital transfer from one family to the other.

In the empirical work reported in the following section, we investigate the relationships between variables designed to measure uncertainty and location specificity and the nature of post-marital residence rules in particular societies.[14] We do not have data available that would allow us to consider size of transfer. This would be better-addressed using data from a number of different villages (or similar small geographic units) within a larger societal structure. While our data are rather rough, we do find some of the predictions of the model to be consistent with the nature of post-marital residence rules across societies.

3 Data and Empirical Findings

Murdock's (1967) *Ethnographic Atlas* contains rough information on the material culture, technology, and customs of 862 different societies from all corners of the world. Of the 862 societies included in the *Atlas*, 239 societies in the *Atlas* are situated in Sub-Saharan Africa, 95 in the Circum-Mediterranean region (encompassing parts of Eastern Asia, the Middle East, Europe, and Northern Africa), 93 in Eurasia, 128 in the Insular Pacific region (Oceania and Southeast Asia), 218 in North America, and 89 in South and Central America.[15] Some of the societies in the data set have been extinct for some time (e. g., the ancient Babylonians), and many differ greatly in their relative states of development. Modern Dutch society, surveyed in 1950 in Anlo parish in Drente province, is in the data set, as are many Native American societies, such as the Navajo and the Pawnee. The data includes a rich variety of societies, including hunter-gatherer societies, peasant and tribal societies, and modern societies. The sources are mostly from the first half of the twentieth century, with some ethnographies dating from the latter part of

the nineteenth century. We utilized a number of summary measures from these data, some of which we constructed ourselves and some of which were constructed by Murdock and his colleagues.

The data largely consists of sets of dummy variables which indicate only the most basic information about each society, for example, whether or not metal working is present in a society or whether or not irrigation is used in agriculture, we are able to use the data to construct some variables which capture the things which our theoretical model deems to be important in explaining the incidence of residence rules. We now describe in turn how we constructed measures of environmental variability, technological sophistication, and the location specificity of marriage investments.

3.1 Environmental variability

In developing a set of variables that follow from our theoretical model and may help in predicting the occurrence of particular residence rules, our first challenge was to consider how one might proxy the degree of environmental variability that each society is subject to.[16] It is obviously very difficult to find data that will capture this idea with any degree of precision. However, we thought that climate data could provide a way in which to consider how societies might vary systematically in the harshness or ease of their environment, particularly in light of the fact that a large portion of the societies in our data set are best described as less-advanced and indigenous. Traditional economies tend to be more reliant on natural resources, and more at the mercy of environmental change.

We use both mean and variance data to consider environmental variation, using readily available information on temperatures (normalizing our collection year to 1900). Accordingly, we collect two types of information on temperature for each society: information on the average temperature, and information on yearly range of temperature; as measured by the highest and lowest monthly temperatures observed in a particular region. From www.worldclimate.com we collected most of the average temperature data and half of the temperature range data. From ingrid.ldgo.columbia.edu we collected a few average temperature data points and the other half of the temperature range data. Peter's Atlas of the World (1989) was used in each case to locate the nearest weather station to the longitude and latitude reported for the society's location in Murdock (1967). In relation to our theory, increased temperature, and a lower temperature spread (signifying a more temperate climate with less uncertainty across time and space) should be positively correlated with adoption of a fixed post marital residence rule to the extent that

these temperature variables are proxying variability of the environment within the range inhabited by each group.[17]

3.2 Agricultural technology

To the degree that societies rely on agriculture and herding, we assume that they are less reliant on location-specific knowledge regarding optimal foraging, and that the usable knowledge can be more easily passed along to new residents. We index a society's proportional reliance on agriculture and herding for sustenance (as opposed to reliance on hunting, gathering, and fishing) using Murdock's measures of these two factors and normalizing their sum to between zero and one hundred percent.

We also assume that more sophisticated agricultural methods reduce further the need for location-specific knowledge, here regarding optimal farming methods for the particular plot of land cultivated. Hence we also form a variable designed to capture the nature of each society's agricultural technology. The *Ethnographic Atlas* contains information on the type and intensity of agriculture for each society. Specifically, Murdock reports whether a society practices 1) no agriculture, 2) very limited and casual agriculture, 3) garden-variety horticulture, 4) extensive and shifting agriculture (slash and burn agriculture), 5) intensive agriculture using irrigation, or 6) intensive agriculture using crop rotation and fertilization. Using this information, we form an index of agricultural technology (agriculture level), giving societies with little or no agriculture the lowest value on the scale (0), and societies with intensive agriculture the highest level on the scale (2).[18] Those societies employing no agriculture or limited and casual agriculture received a zero on our scale, those societies engaging in horticulture or extensive agriculture a one on our scale, and those societies practicing intensive agriculture a two on our scale. Our reasoning is that societies with more intensive levels of agriculture are less at the mercy of environment and the characteristics of the land. As agriculture grows more intensive, the productivity of land is less a function of the environment as land can be improved, irrigated, and fertilized. Thus, more intensive agricultural methods may decrease the location specificity of human capital.

In one of our specifications, we employ some complementary measures of technological sophistication: dummy variables capturing 1) whether or not the plow is used in agriculture, and 2) whether or not metalworking is used in agriculture. We reason that these measures are most easily motivated as exogenous (i.e., determined by technological innovation) to any processes that might jointly determine marital residence rules and agricultural practice. Further, the presence of these

two technologies may go a long way in rendering farm land more equal in quality, and making farmers less vulnerable to idiosyncratic environmental characteristics of the land.

3.3 Location specificity

In addition to variability, the other critical components of our model are location specificity and the value of human capital investments outside of marriage. These two components of the model are extremely difficult to operationalize for testing from available data. However, we reason that the presence of a functioning market for labor, in particular a skilled labor market, would imply low location specificity of human capital and also imply a high value of human capital outside of marriage. A market requires some degree of uniformity across the goods sold in the market, and thus the presence of a skilled labor market may indicate that human capital value is not relatively specific to location and that acquired skills are less idiosyncratic across individuals. If skilled labor can be bought or sold in a market, the value of human capital outside of marriage is likely to be higher. Therefore, the increased presence of skilled labor markets is likely to move societies towards bilocal or neolocal rules, as opposed to patrilocal or matrilocal rules. Unfortunately, Murdock does not include information on the presence of markets, but using information from a smaller sample of societies, we develop a predictive model of the likelihood a particular society has functioning skilled and unskilled labor markets. We then use this model to estimate the probabilities for every society in our larger data set of having functioning skilled labor markets. We develop a similar model to predict the probability of occurrence of unskilled labor markets for contrast with our results on skilled labor markets. Intuitively, since unskilled labor by definition does not require a high degree of skill development and hence is not influenced by human capital acquisition, the presence of an unskilled labor market should have little predictive power in determining the form of the marriage rule.

Our labor market information comes from Pryor's (1977) book *The Origins of the Economy*. Pryor's data set contains 60 societies, and almost all of the societies in Pryor's data are also in Murdock's database (we were able to match 57 of the 60 societies). Pryor notes for each society in his sample whether or not there is an "important" unskilled labor market, and whether or not there is an "important" skilled labor market. Pryor judges labor markets to be important if they account for more than five percent of the transactions governing the allocation of skilled labor in a society. We do not present in this paper a theoretical model of the origins and growth of labor markets; such a task would certainly be interesting

and would make an excellent topic for future research, but is well beyond the scope of this paper. Rather, through a process of experimentation, we sought to find a few instrumental variables in Murdock's data set that appear to predict the presence of skilled and unskilled labor markets, that are also not highly correlated with marriage customs.

Our simple models of skilled and unskilled labor market emergence are shown in Tables 2 and 3. Table 2 shows the most useful instruments in predicting the presence of skilled labor markets. The first instrumental variable equals one if dual stratification is present in the society, zero otherwise. Dual stratification occurs when a society is segmented into elite and worker classes as coded by Murdock in the *Ethnographic Atlas*. We also found that the degree of craft specialization (measured by a craft specialization index) correlated with the presence of a skilled labor market. We constructed this index of craft specialization by noting first whether or not a basket of tasks, including metal working, leather working, potting, boat building, and house construction were present in each society, and then noting whether or not each task was performed by craft or industrial specialists, information available in Murdock's data. For each of the tasks performed by craft specialists, we gave a society one point. If industrial specialists perform the task, we awarded the society two points, reasoning that the presence of industrial specialists indicated a larger degree of specialization present in the society. Thus, our total craft index runs from zero (no crafts performed by specialists) to ten (all crafts performed by industrial specialists). As one would expect, this variable has a strongly positive impact on the likelihood of observing a skilled labor market. We also found that a dummy variable which equals one if the society practices intensive agriculture, employing crop rotation and fertilization on fixed plots (see the discussion in section 3.2 on agricultural technology for coding of these variables), zero otherwise, and another dummy which equals one if the society practices extensive, shifting agriculture (slash-and-burn agriculture), zero otherwise to be useful instruments in predicting the presence of a skilled labor market. Apparently, societies employing intensive methods of agriculture are much more likely to have a skilled labor market, and societies employing extensive agriculture are much less likely to have one.

As mentioned previously, for the sake of contrast, we also developed a set of instruments predicting the presence of unskilled labor markets. Table 2b reports these results. Our intensive agriculture dummy proved to be a good instrument for the presence of an unskilled labor market and our dual stratification dummy was significantly negatively correlated with unskilled labor market presence, in contrast with our skilled labor market model. Additionally, we found the use of

animals in plow cultivation (captured by a dummy equal to one if animals are employed in plowing, zero otherwise) to be negatively correlated with the presence of an unskilled labor market, perhaps because animals replace unskilled laborers. Further, we found that nomadic societies (captured by a dummy equal to one if the society was reported by Murdock to be nomadic, zero otherwise) were less likely to have an unskilled labor market. Societies that rely more upon agriculture for subsistence (percentage of subsistence from agriculture) were less likely to have an unskilled labor market, and societies that relied more upon animal husbandry were more likely to have a unskilled labor market.[19] The two equations in Tables 2 and 3 show the instrumental variables equations used to predict the probability of presence of unskilled and skilled labor markets for the larger data set. These predicted probabilities were then included as variables in our following regression model.

3.4 Potential for rule enforcement

An issue we deliberately skirted in the theoretical section so as to keep the model simple, but one that is nonetheless important, is the ability of society to enforce customs and rules. Our implicit modelling assumption was that society can inflict sufficient punishment on transgressors of social rules, and in essence perfectly enforce any rule it so chooses. Societies, however, are not uniformly endowed in their capacity to enforce and maintain rules, and the costs of enforcing rules is likely to have an impact on the adoption of particular sets of rules. That having been said, a society's capacity to enforce its rules is not easy to capture, especially considering the limited nature of Murdock's data and the low levels of development of the majority of the societies in our data set. These data do, however, offer rather detailed information on community and kin group structure. We consider various measures that indicate large, geographically far-reaching versions of these structures, or the converse, as proxies for enforceability. Our reasoning is that societies with well-defined and farther-reaching familial structures will be more able to enforce social rules. Moreover, societies with well-defined and extensive kin groups should also be more able to enforce rules.

Hence, we include dummy variables for both small and large community sizes (as opposed to the omitted category of medium community size), hypothesizing that small community size will be negatively related to rule fixity, and large community size positively related to rule fixity. We also include a dummy if there are reported to be large matrilineal kin groups in a society, and a similar dummy for patrilineal kin groups, and assume that these will both be positively related

to rule fixity. For all of these variables, we recognize the possible endogeneity of these variables in regards to their joint determination with residence rules. Because developing instruments for each of these variables is clearly impossible, we instead present results both with and without these variables to see their effects.

Similarly, we also consider the existence of monetary transfers (whether bride price, dowry, or "gift exchange") as a dummy variable in one of our specifications below. This existence of transfers is clearly developed as endogenous within our theoretical model as presented above. However, here we consider the question of whether a fixed rule can exist without the possibility of transfers. The model clearly implies that fixed rules would not be feasible without the possibility in the society (and indeed at least the occasional occurrence) of transferring resources from one family to the other. Hence our theory makes the strong prediction that transfers should be positively related to the existence of a fixed residence rule.

3.5 Econometric specification and results

Using various subsets of the potential determinants developed in the preceding sections, we attempt to predict which societies will have a fixed post-marital residence rule (patrilocal or matrilocal) as opposed to a flexible (bilocal or neolocal) "rule" (societies with no common marital household are dropped from the sample).

Table 4 summarizes the variables described above and used in our subsequent analysis. Means and standard deviations are presented for the sample as a whole and separately for societies by whether they have fixed or flexible rules. Statistically significant differences occur in variable magnitudes across the two categories of societies in several cases. Societies with fixed residence rules have higher average temperature and lower temperature variation than societies with flexible residence, which is consistent with our theory. However, counter to our theory, from simple mean comparisons they also appear to rely more heavily on agriculture and herding and operate at a higher level of agricultural technology. They are also more likely to engage in metalworking. Also counter to our theory, probability of functioning labor markets, either skilled or unskilled, does not differ significantly between the categories. Transfers are much more likely to occur in societies with fixed residence rules, but also occur in slightly more than fifty percent of societies with flexible residence. This latter pattern is not necessarily problematic for our theory, as transfers may occur under flexible rules as well; indeed, one might argue that transfers would always need to occur if societies were behaving in accordance with our theory more broadly considered. Finally, a number of societal structure variables differ between the societal groupings, and generally in the way we

predicted: small community units are more prevalent in flexible societies, while large community units and large patrilineal kin groups are more prevalent in fixed societies.

Given the binary nature of the dependent variable, either a probit or logit specification is warranted; we ran both specifications, but report only the results from the logistic regressions, as the qualitative results are identical (i.e., sign and statistical significance). The regressions were run using the Probit and Logistic procedures in SAS V. 8.1.

In order to consider the cumulating and offsetting effects of sets of the variables in Table 4, we ran ten specifications, each different in terms of the number and type of variables included. This allows us to see which results are particularly robust to specification, and which variables are interrelated. Table 5 presents our regression results. The specifications in general increase in inclusiveness from left to right across the columns, with generally increasing ability to "predict" the fixed v. flexible rule outcome as measured by the overall goodness of fit.

All specifications contain average yearly temperature and temperature range. Average temperature is positively related to presence of a fixed rule in all specifications in roughly the same amount. Temperature range, however, is only weakly statistically significant in one specification, thereby failing to support one of our strongest model predictions. Still, it is possible that higher temperature range also captures some unobserved component of environmental variability.

All specifications also contain our two estimated probabilities of functioning skilled and unskilled labor markets. The probability of a skilled labor market is significantly negatively related to presence of a fixed rule across all but one specification (we discuss this result in more detail below). Unskilled labor markets appear to have no relation to presence of a fixed rule. These results are jointly an interesting finding in accord with our theory. Recall that, according to our theory, the negative dependence between skilled labor markets and fixed rules stems from the fact that the presence of a skilled labor market increases the outside-marriage value of human capital, lessening the marriage specificity of assets and generating greater human capital investment incentives under choice. The insignificance of the unskilled labor market in any of the regressions buttresses this result. This is as predicted, since investment in human capital is not important in unskilled tasks.

A variable indicating presence of transfers (dowry, brideprice, etc.) is included in four of the specifications to gauge their impact on the other coefficients and to observe its relation to residence rules. Notably, transfers are significantly positively related to having a fixed rule, which again we take as a necessary condition for a

fixed rule to occur. This also implies that marital surplus varies significantly across locations so as to require transfers to offset the differential value created under a fixed rule regime. In general, inclusion of the transfer variable does not have a large and consistent impact on the other coefficients (as seen in the matching four specifications that differ only by exclusion of this variable).

The agricultural technology measures are combined in various formats, ranging from specifications that try to include only the barest technological measures (plow presence and metalworking presence) up through specifications that also (or instead) include summary measures of agricultural technological level and importance for the society. Reliance on agriculture has little relationship to fixed rules in most specifications, but enters with positive sign (contrary to our prediction) when it is significant. The agricultural technology level is occasionally significant and enters with negative sign in keeping with our prediction. Use of plow technology is significantly negatively related to fixed rule adoption, also as our theory predicts.[20] Metalworking, however, enters with significant positive sign, opposite to our prediction.

The latter specifications (g. through j.) include a set of both community and family organizational structure variables (again, thought of in our model as capturing enforceability effects, although they may have other effects as well, and may be determined endogenously). These variables are all significant save for the presence of large matrilineal kin groups. Small community units have the expected negative relationship to fixed rule presence, while large community units have the expected positive relationship. The existence of large patrilineal kin groups has the expected positive relationship with fixed rule presence. These results are supportive of our argument that enforceability increases the likelihood of fixed rule observance in a society. Not surprisingly, including all of the family structure variables and the technological variables reduce the significance of the skilled labor market variable. This is likely due to the fact that technological sophistication partially determines the skilled labor market variable, and our theory predicts that the skilled labor market variable should only matter for marriage residence to the extent that it captures specific features of technology such as location specificity.

We tested the robustness of these results by utilizing different sampling frameworks. The anthropologists who have attempted cross-cultural analysis, notably Murdock himself, have been concerned with oversampling related cultures. Thus Murdock developed two different classification schemes, one as reported in his 1967 book *Ethnographic Atlas* that forms 412 "cultural clusters," and one as reported in his 1971 book *Atlas of World Cultures* that groups the clusters into 150 "cultural provinces," twenty-five in each of six world regions. In addition, the

Standard Cross-Cultural Sample developed by Murdock and White (1969) and contains "the best-described society in each of 186 cultural provinces of the world chosen at a time when cultural independence is maximal" (White 1985). However, while cross-societal correlation is a concern, these groupings have ad hoc features as well, although they are related both to geographic location and linguistic relations. While the anthropologists who mainly use these data are justifiably wary of drawing general conclusions based on skewed samples, they are not generally concentrating on specific testable hypotheses using multiple regression techniques. We are loath to throw out usable information on societies by selecting randomly from these clusters or using the SCCS sample when we can instead use control variables to help adjust for these correlations while still gaining additional information from potential variations between closely-related cultures. Indeed, neither linguistic nor geographic proximity is perfectly correlated with adoption of postmarital location rules. Multicollinearity, is likely exacerbated by reducing the sample size even as the various subsample construction methods aim to maintain variability. However, we do consider whether our results as reported in Table 5 using the largest available sample are consistent with results derived from smaller samples based on the rubric of cultural clusters.

To do so, we first ran our regressions using weights based on the inverse of the number of societies in each cultural cluster (Table 6). We also drew two independent samples by randomly selecting one society from each of the 412 clusters in the original Murdock system (Tables 7 and 8). The means and standard deviations of the included variables are not statistically significantly different from those shown for the full sample in Table 5. All three samples produce less well-fitting regressions as measured by the pseudo R-squares. The coefficients from the weighted regressions are generally less likely to be statistically significant but do not exhibit sign reversals relative to those shown in Table 5. As compared to the coefficients shown for the full sample in Table 5, the coefficients for the smaller two samples are less likely to be statistically significantly different from zero as the standard error of the estimates increases. Thus inference based on the more restrictive samples, as with the weighted sample, tends to reduce the support for finding an effect of our included variables. However, there are no statistically significant sign reversals in these regressions, so the causal direction, if there at all, is in the direction shown in Table 5. In all three tables, large patrilineal kin groups have a larger positive effect on fixed rule probabilities and plow technology has a more pronounced negative effect than in Table 5.

We also ran our regressions on the SCCS sample of societies. This produces a particularly small sample size, as only 161 societies have sufficient data to be

included in the regressions. These results are similar in their lack of statistical significance and lack of difference from Table 5 in terms of sign changes, so we desist from presenting them.

Thus these findings are mixed. We find weak support for base-level environmental effects on rule adoption. Agricultural sophistication has a weakly negative relationship with rule adoption. Skilled labor markets appear to matter in reducing reliance on a fixed rule, while unskilled labor markets appear to have no significant impact on rule adoption, which is relatively our strongest result. We find evidence that other structures within societies support the presence of fixed rules (or at least coexist with fixed rules). We would characterize these findings as exploratory but encouraging, and as more indicative of the potential for further development and investigation of this line of theorizing, both at a systematic and at a case study level, than strongly supportive of our simple theory as it currently stands.

Aside from issues relating to sample construction, there are obviously issues relating to the underlying construction of the variables: the highly aggregate nature of the available information, the endogenous nature of some of the included variables, and questions about the correctness of the coding of the variables by Murdock. It would be interesting but challenging to go back to the original sources (as contained in the Human Relations Area Files) and attempt to recode these data and see if any additional data were available regarding variations within societies in the use of location rules and other included variables (thus perhaps generating additional observations at a subsocietal level).

If more work were to be done at this aggregated level, additional control and explanatory variables would need to be incorporated. For instance, Ember and Ember (1971) consider the role of warfare in determining marital residence rules for a set of 33 societies. This variable would need to be carefully coded for a much larger sample of societies than those contained in the *Ethnographic Atlas*. Additional empirical work in this area might be more profitably directed at characterizing variations within societies, including observing differences in rules and transfer amounts between villages and/or classes, as well as changes over time, and considering them in light of differences in environmental variability and labor markets measured at the same level.

Another extension along both theoretical and empirical grounds would be to consider the gender division of labor in these societies simultaneously with the marital location decision and the types of labor performed. In Baker and Jacobsen (2005), we take a step towards theorizing why the gender division of labor is prescribed in most societies. Development of a broader theory of why multiple social

rules exist along gender lines, how these rules interact, and what environmental features cause variation in these rules is a large task that will require commitment of more researchers to this research agenda.

4 Conclusions

We have argued that fixed marriage customs, often observed in a spectrum of pre-modern societies, may be a response to contracting difficulties created by the fact that human capital investments in future wives and husbands are noncontractable and must be made well before the date of actual marriage. We show in a simple model that fixed marriage customs can overcome this difficulty by fixing the terms of the marriage contract and ruling out the possibility of renegotiation at the contract (marriage) date. In our model there is a cost associated with rigidity, however: it is impossible for parties to engage in pareto-improving renegotiation at the wedding date. We find some evidence in support of some of the predictions stemming from our model, but are unable to confirm strongly our human capital-based view of how fixed residence rules are determined.

Our theory suggests that the increasingly-observed pattern of neolocality, which is so prevalent in societies such as the United States as to be considered a rule in itself, is a natural outcome given the increased use of formal labor markets, including ones for more specialized labor that operate over wide geographic areas, and the reduced importance of knowledge of local environmental conditions in order to earn one's living. In a Darwinian view, societies that either relinquish their fixed rule or had a flexible rule to begin with might well have the advantage over societies that continue to maintain fixed rules beyond their useful lifespan.

Our view that some cultural institutions exist so as to restrict the bounds of contracting behavior may have a substantial amount of applications not only regarding marriage markets but regarding many other behaviors as well. This suggests that these institutions have an important economic role in encouraging investment in particular types and amounts of capital. It also suggests a potential dynamic approach to considering the demise of such institutions: as markets arise, they replace custom in determining the types of contracts that can be made and the terms on which they are made.

Notes

1. An excellent source for detailed descriptions of marriage institutions and transfers in a variety of cultures is Goody (1990)
2. Though recently there has been some cross-cultural work done in economics. See, for example, Agarwal (1994), Baker (2003), Baker and Miceli (2005), Anderson and Swimmer (1997), and Stodder (1992) for some approaches to cross-cultural analysis.
3. Recent papers discussing this result in full detail include Che and Hausch (1999), Che and Chung (1999), Maskin and Tirole (1999), and Hart and Moore (1999).
4. Indeed, one novelty of our approach is that the magnitude and direction of transfer payments associated with marriage are endogenized.
5. Williamson (1983, 1985) is the seminal work on the hold-up problem. A number of researchers have focused on the cooperative investment/hold-up problem: In addition to the recent papers mentioned in footnote 1, see also Aghion, Dewatripont, and Rey (1994), Chung (1992), Noldecke and Schmidt (1995), Hart and Moore (1988), and Moore and Repullo (1988) for discussion of aspects of this problem.
6. See Grossman and Hart (1986), Hart and Moore (1990), and Williamson (1983). See also Aghion and Bolton (1992), Aghion and Tirole (1997), and Rogerson (1992).
7. See Che and Chung (1999).
8. In Baker and Jacobsen (2005), we study a model in which marriage partners bargain in an environment with opportunity for additional search if bargaining breaks down. The results are qualitatively similar, but more complex, to those presented in this paper. See also Konrad and Lummerud (2000). The critical thing is that parties have some bargaining power. The results probably would not carry through in a model in which the marriage market was frictionless, and indeed, the nature of human capital investments is not obvious in this case. On this question, see Peters and Siow (2002).
9. While we therefore suppose that customs serve to enhance efficiency, we do not mean to preclude the importance of other factors in determining custom. For a discussion of these points, see Greif (1994, 1998).
10. We thank an anonymous referee for bringing this possibility to our attention.

11. O^W_w and O^H_h denote the partial derivatives of O^W and O^H with respect to w and h.
12. The second order conditions require that

$$\{O^W_{ww} + \frac{1}{2}\overline{\epsilon}(V^W_{11} + V^H_{11}\delta^2_w)\}\{O^H_{hh} + \frac{1}{2}\overline{\epsilon}(V^H_{22} + V^W_{22}\delta^2_h)\} \geq \{\frac{1}{2}\overline{\epsilon}(V^H_{12}\delta_w + V^W_{12}\delta_h)\}^2$$

hold. This condition means that the degree of complementary between the two investments cannot be so large so as to overwhelm the concavity of the value function.
13. Note that while our model is couched such that transfers occur at the time of marriage, it is not literally necessary that the entire amount be transferred at that point, only that the total value be agreed upon at that point and not be subject to subsequent renegotiation. While it might be simpler for enforcement purposes to transfer amounts at that point, it does not preclude installment payments. In addition, this does not preclude other transfers between households that take place subsequently for other reasons such as additional risk-pooling and income sharing; see Rosenzweig and Stark (1989) for a discussion of how such transfers may occur between households subsequent to their link through marriage.
14. We are unable to address the question of what happens when marriage occurs across two societies with different post-marital location rules. Essentially we only consider cases where people marry within a particular societal structure. The available data do not allow us to consider these situations empirically.
15. Many cross-cultural analyses rely on a stratified subset of these data known as the Standard Cross-Cultural Sample (SCCS), which contains 186 societies, all but three of which are in the original Murdock sample, and has additional variables coded for all or part of this sample. We did some additional analysis using the SCCS, but found it unsatisfactory because the additional variables either did not capture the concepts we are interested in, or were coded for only a subset of the SCCS. Thus the loss of sample size is not offset by increased data availability for the societies included.

16. As the data contains no information on household or village-specific data on environmental variability, we are unable to explore how much environmental variability measured at this level affects the likelihood of adopting a fixed rule, both through affecting the relative importance of location-specific human capital. This issue has been explored in regards to intergenerational transfers by Rosenzweig and Wolpin (1985) and Grimard and Hamilton (1999).

17. As an alternative measure of the temperate/verdant nature of different environments, we also collected average yearly rainfall data for each of our societies, using the same longitude and latitude point. This variable proved to be statistically insignificant when used either alone or in tandem with our other environmental variables, and we have not reported these results herein. A referee also suggested that we extend our empirical analysis to consider information on variation in the temperature range and water availability from year to year. We followed up on this suggestion by using data from the Global Historical Climatology Network (1992), again matching each society to its nearest weather station, and computing both standard deviations across yearly averages and coefficients of variation for all available years for each station. Neither the standard deviations nor the coefficients of variation proved to be statistically significant when entered in the regressions in place of or in addition to within-year temperature range, and the new measure of rainfall variation also was not statistically significant. We also ran specifications using climate type dummy variables, relying on the Koppen five-level classification (tropical, dry, temperate, cold, polar) and rejected joint significance for the set; there was a small negative effect of polar (only 11 societies in our full sample). The Koppen classification data was constructed with the aid of Peter Guth using data from the dataset Global Climate Normals (1990).

18. We also recoded our agricultural technology level index into six rather than two levels, and also tried entering these levels as dummies rather than as an index. These regression specifications do not outperform our reported ones.

19. Pryor (1977) also finds that societies that rely upon animal husbandry tend to have unskilled labor markets. Indeed, both of our models are similar to the variety of models that Pryor fits outlining a variety of factors leading to the emergence of markets.

20. We also tried alternative specifications wherein the various variables relating to reliance on agriculture/herding and/or the agricultural technology level were interacted with the temperature range. This interaction term was not statistically significant and the specification did not fit better than the ones shown using noninteracted terms. Per a referee's suggestion, we also constructed an index that interacted reliance on agriculture/herding with the agricultural technology level and ran specifications that included this variable both in lieu of and in addition to the two underlying variables. This variable was never statistically significant and these specifications did not outperform our reported ones.

References

[1] Agarwal, Bina. 1994. *A Field of One's Own: Gender and Land Rights in South Asia* Cambridge: Cambridge University Press.

[2] Aghion, Phillipe and Patrick Bolton. 1992. "An Incomplete Contracts Approach to Financial Contracting." *Review of Economic Studies* 59: 473-94.

[3] Aghion, Phillipe, Mathias Dewatripont and Patrick Rey. 1994. "Renegotiation Design with Unverifiable Information." *Econometrica* 62: 257-82.

[4] Aghion, Phillipe, and Jean Tirole. 1997. "Formal and Real Authority in Organizations." *Journal of Political Economy* 105: 1-29.

[5] Anderson, C. Leigh, and Eugene Swimmer. 1997. "Some Empirical Evidence on Property Rights of First Peoples," *Journal of Economic Behavior and Organization* 33: 1-22.

[6] Anderson, Siwan. 2003. "Why Dowry Payments Declined with Modernization in Europe but Are Rising in India," *Journal of Political Economy* 111: 269-310.

[7] Baker, Matthew J. 2003. "An Equilibrium Conflict Model of Land Tenure in Hunter-Gatherer Societies," *Journal of Political Economy* 111: 124-73.

[8] Baker, Matthew J. and Joyce. P. Jacobsen. 2005. "Marriage, Specialization, and the Gender Division of Labor," United States Naval Academy Working Paper No. 2-2003.

[9] Baker, Matthew J. and Thomas J. Miceli. 2005. "Optimal Land Inheritance Rules: Theory and Cross Cultural Evidence," *Journal of Economic Behavior and Organization* 56(1): 77-102.

[10] Becker, Gary S. 1991. *A Treatise on the Family, Enlarged Edition.* Cambridge, Massachusetts and London: Harvard University Press.

[11] Boserup, Ester. 1970. *Woman's Role in Economic Development.* London: George Allen and Unwin Ltd.

[12] Botticini, Maristella and Aloysius Siow. 2003. "Why Dowries? " *American Economic Review* 93: 1385-98.

[13] Che, Yeon-Koo and Donald B. Hausch. 1999. "Cooperative Investments and the Value of Contracting." *American Economic Review* 89: 125-47.

[14] Che, Yeon-Koo, and Tai-Yeong Chung. 1999. "Contract Damages and Cooperative Investments." *Rand Journal of Economics* 30: 84-105.

[15] Chung, Tai-Yeong. 1992. "Incomplete Contracts, Specific Investment, and Risk Sharing." *Review of Economic Studies* 58: 1031-42.

[16] Driver, Harold E. and William C. Massey. 1957. *Comparative Studies of North American Indians. Transactions of the American Philosophical Society* 47: 165-456.

[17] Ember, Carol R. 1978. "Myths about Hunter-gatherers." *Ethnology* 17: 439-448

[18] Ember, Melvin and Carol R. Ember. 1971. "The Conditions Favoring Matrilocal Versus Patrilocal Residence." *American Anthropologist* 73: 571-594.

[19] Foster, Andrew D. and Mark R. Rosenzweig. 1999. "Missing Women, the Marriage Market and Economic Growth." Working Paper, Brown University, January.

[20] The Global Historical Climatology Network, Version 1. 1992. http://cdiac.esd.ornl.gov/ghcn/ghcn.html. Accessed March-April 2005.

[21] Global Climate Normals 1990. http://www.worldclimate.com/sources.htm. Accessed March-April 2005.

[22] Goody, Jack. 1990. *The Oriental, the Ancient, and the Primitive: Systems of Marriage and the Family in the Pre-industrial Societies of Eurasia.* Cambridge and New York: Cambridge University Press.

[23] Greif, Avner. 1994. "Cultural Beliefs and the Organization of Society: A Historical and Theoretical Reflection on Collectivist and Individualist Societies." *Journal of Political Economy* 102: 912-950.

[24] Greif, Avner. 1998. "Historical and Comparative Institutional Analysis." *American Economic Review Papers and Proceedings* 88: 80-84.

[25] Grimard, Franque and Hamilton, Barton. 1999. "Estimating the Elderly's Returns on the Farm: Evidence from Cote D'Ivoire." *Journal of Development Economics* 58: 513-551.

[26] Grossman, Sanford and Hart, Oliver. 1986. "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration." *Journal of Political Economy* 94: 691-719.

[27] Hart, Oliver and John Moore. 1990. "Property Rights and the Nature of the Firm." *Journal of Political Economy* 98: 1119-58.

[28] IRI/LDEO Climate Data Library. http://ingrid.ldgo.columbia.edu. Accessed January-April 2000.

[29] Kelly, Robert L. 1995. *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways.* Washington, D.C.: Smithsonian Institution Press.

[30] Konrad, Kai A., and Lommerud, Kjell Erik. 2000. "The Bargaining Family Revisited," *Canadian Journal of Economics* 33: 471-487.

[31] Lee, Richard B. and Irven DeVore (eds). 1968. *Man the Hunter.* Chicago, Ill.: Aldine Publishing.

[32] Maskin, Eric and Tirole, Jean. 1999. "Unforeseen Contingencies and Incomplete Contracts." *Review of Economic Studies* 66: 83-114.

[33] Martin, M. Kay, and Barbara Voorhies. 1975. *Female of the Species.* New York:Columbia University Press.

[34] Moore, John and Rafael Repullo. 1988. "Subgame Perfect Implementation." *Econometrica* 56: 1191-1220.

[35] Murdock, George Peter. 1967. *Ethnographic Atlas*. Pittsburgh, Penn.: University of Pittsburgh Press.

[36] Murdock, George Peter. 1949. *Social Structure*. New York: Macmillan Company.

[37] Murdock, George Peter. 1981. *Atlas of World Cultures*. Pittsburgh, Penn.: University of Pittsburgh Press.

[38] Murdock, George Peter and Douglas R. White. 1969. "Standard Cross-Cultural Sample." *Ethnology* 8: 329-69.

[39] Noldecke, Georg and Klaus Schmidt. 1995. "Option Contracts and Renegotiation: A Solution to the Hold-up Problem." *Rand Journal of Economics* 26: 163-79.

[40] Peters, Arno. 1989. *Peters Atlas of the World*. Harlow: Longman.

[41] Peters, Michael and Aloysius Siow. 2002. "Competing Premarital Investments." *Journal of Political Economy* 110: 592-608.

[42] Pryor, Frederick. 1977. *The Origins of the Economy*. New York: Academic Press.

[43] Rao, Vijayendra. 1993. "The Rising Price of Husbands: A Hedonic Analysis of Dowry Increases in Rural India." *Journal of Political Economy* 101: 666-677.

[44] Rogerson, William. 1992. "Contractual Solutions to the Hold-up Problem." *Review of Economic Studies* 59: 774-94.

[45] Rosenzweig, Mark R and Stark, Oded. 1989. "Consumption Smoothing, Migration, and Marriage: Evidence from Rural India." *Journal of Political Economy* 97: 905-926.

[46] Rosenzweig, Mark R and Wolpin, Kenneth I. 1985. "Specific Experience, Household Structure, and Intergenerational Transfers: Farm Family Land and Labor Arrangements in Developing Countries." *Quarterly Journal of Economics* 100: 961-987.

[47] Service, Elman Rogers. 1962. *Primitive Social Organization: An Evolutionary Perspective*. New York: Random House.

[48] Steward, Julian Haynes. 1955. *Theory of Culture Change: The Methodology of Multilinear Evolution*. Urbana, Ill.: University of Illinois Press.

[49] Stodder, James. 1995. "The Evolution of Complexity in Primitive Exchange: Empirical Tests," *Journal of Comparative Economics* 20: 1-31.

[50] Textor, Robert B. (compiler). 1967. *A Cross-Cultural Summary*. New Haven, Conn.: HRAF Press.

[51] White, Douglas R. 1985. http://eclectic.ss.uci.edu/ dr-white/worldcul/sccs.html. Accessed June 2004.

[52] Williamson, Oliver E. 1983. "Credible Commitments: Using Hostages to Support Exchange." *American Economic Review* 73: 519-40.

[53] Williamson, Oliver E. 1985. *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*. New York: Free Press, and London: Collier Macmillan.

[54] WorldClimate.Com. 1996-1998. http://www.worldclimate.com. Buttle and Tuttle Ltd. Accessed January-April 2000.

Profile	*Definition of Profile*	*%*
Patrilocal Profiles		**73.7%**
Patrilocal	Normal residence with or near the male patrilineal kinsmen of the husband	45.5%
Virilocal	Equivalent to patrilocal, but confined to instances where the husband's patrikin are not aggregated in patrilocal and patrilineal kin groups	23.1%
Avunculocal	Normal residence with or near the maternal uncle or other male matrilineal kinsmen of the husband	4.3%
Optionally Patrilocal, Avunculocal, or Virilocal		0.8%
Matrilocal Profiles		**13.1%**
Matrilocal	Normal residence with or near the female matrilineal kinsmen of the wife	5.0%
Uxorilocal	Equivalent to matrilocal, but confined to instances where the wife's matrikin are not aggregated in matrilocal and matrilineal kin groups	8.1%
Bilocal Profiles		**7.6%**
Ambilocal	Residence established optionally with or near the parents of either the husband or the wife, depending upon circumstances or personal choice, where neither alternative exceeds the other in actual frequency by a ratio of greater than 2:1.	7.2%
Optionally Uxorilocal or Avunculocal		0.4%
Other Profiles		**5.6%**
Neolocal	Normal residence apart from the relatives of both spouses or at a place not determined by the kin ties of either	4.7%
Duolocal/Natolocal	No common household established; both spouses remain in their natal households	0.9%

Table 1: Marital residence profiles and frequencies. Profiles follow descriptions in Murdock (1967: 48). Number of societies with a description of marital residence = 859 (out of a total of 862 societies)

Dependent Variable: Presence of a skilled labor market	
Independent Variables:	*Estimated Coefficient (Standard Error)*
Intercept	-1.57*** (0.52)
Dual stratification present	2.08** (1.01)
Total crafts production index	1.03** (0.37)
Intensive agriculture present	1.80** (0.97)
Extensive agriculture present	0.012** (0.006)
Wald test statistic	13.29**

Table 2: Logit model to predict presence of skilled labor markets (N=57). Dependent variable = presence of a skilled labor market. *(***=99% sig., **=95% sig., *=90% sig.)*

Dependent Variable: Presence of an unskilled labor market	
Independent Variables:	*Estimated Coefficient (Standard Error)*
Intercept	3.02 (3.07)
Dual stratification present	-4.54** (2.50)
Animal use in cultivation present	-3.79** (1.99)
Intensive agriculture present	5.16** (2.51)
Nomadic society	-5.05** (2.51)
Percentage of subsistence from agriculture	-1.47** (0.74)
Percentage of subsistence from animal husbandry	2.43*** (0.90)
Wald test statistic	8.46

Table 3: Logistic model to predict presence of skilled labor markets (N=57). Dependent variable = presence of a skilled labor market *(***=99% sig., **=95% sig., *=90% sig.)*

Variable description	*All societies*	*Societies with fixed residence rule*	*Societies with flexible residence*
Average temperature (degrees Fahrenheit)	66 (16)	67** (16)	61 (19)
Yearly temperature range	34 (25)	34** (25)	40 (28)
Reliance on agriculture/herding (0-100)	56 (35)	57** (34)	46 (36)
Agricultural technology level (0-2)	1.44 (0.82)	1.46** (0.81)	1.28 (0.88)
Use of plow technology (yes=1)	0.13 (0.33)	0.12 (0.32)	0.19 (0.40)
Use of metalworking (yes=1)	0.42 (0.49)	0.44** (0.50)	0.26 (0.44)
Probability of a skilled labor market	0.32 (0.31)	0.32 (0.30)	0.35 (0.31)
Probability of an unskilled labor market	0.22 (0.35)	0.23 (0.36)	0.17 (0.30)
Transfers observed with marriage? (yes=1)	0.76 (0.43)	0.80** (0.40)	0.51 (0.50)
Small community units? (yes=1)	0.08 (0.27)	0.06** (0.24)	0.21 (0.41)
Large community units? (yes=1)	0.30 (0.46)	0.33** (0.47)	0.08 (0.28)
Large matrilineal kin groups? (yes=1)	0.13 (0.33)	0.13 (0.34)	0.09 (0.28)
Large patrilineal kin groups? (yes=1)	0.35 (0.33)	0.39** (0.49)	0.07 (0.25)
Number of societies	848	744	104

Table 4: Variable means and standard deviations, overall and by fixed and flexible residence rule. (** *denotes significantly different from the flexible residence mean at 95% on a two-tailed t-test)*

Variable description	*a.*	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*	*h.*	*i.*	*j.*
Intercept	0.47 (0.81)	0.30 (0.83)	0.31 (0.81)	-0.42 (0.83)	0.12 (0.83)	-0.68 (0.85)	0.12 (0.88)	-0.23 (0.89)	-0.21 (0.89)	-0.56 (0.91)
Average temperature (degrees Fahrenheit)	0.02** (0.01)	0.02** (0.01)	0.02** (0.01)	0.02** (0.01)	0.02** (0.01)	0.02** (0.01)	0.02* (0.01)	0.02* (0.01)	0.02* (0.01)	0.02* (0.01)
Yearly temperature range	0.002 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.012* (0.007)	0.005 (0.007)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Reliance on ag./herding (0-100)			0.015 ** (0.006)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01* (0.01)	0.01* (0.01)	0.01 (0.01)
Ag. technology level (0-2)			-0.41* (0.23)	-0.25 (0.23)	-0.44* (0.23)	-0.28 (0.23)	-0.19 (0.25)	-0.12 (0.24)	-0.22 (0.24)	-0.15 (0.25)
Use of plow technology?		-1.27*** (0.40)			-1.32*** (0.41)	-1.44*** (0.43)			-1.44*** (0.47)	-1.51*** (0.47)
Use of metalworking?		1.50*** (0.36)			1.48*** (0.39)	1.20*** (0.41)			1.21*** (0.42)	1.05** (0.43)
Prob. of skilled labor market	-0.51 (0.36)	-0.84* (0.46)	-0.87** (0.40)	-0.95** (0.41)	-1.03** (0.47)	-0.85* (0.48)	-0.83** (0.42)	-0.86** (0.43)	-0.70 (0.49)	-0.61 (0.50)
Prob. of unskilled labor market	0.56 (0.35)	0.29 (0.37)	0.31 (0.37)	0.08 (0.38)	0.17 (0.38)	-0.10 (0.39)	0.08 (0.39)	-0.04 (0.40)	-0.02 (0.40)	-0.17 (0.41)
Transfers with marriage?				1.19*** (0.24)		1.08*** (0.24)		0.62** (0.25)		0.56** (0.26)
Small community units?							-0.93*** (0.32)	-0.79** (0.33)	-0.78** (0.32)	-0.67** (0.33)
Large community units?							1.31*** (0.40)	1.20*** (0.40)	1.34*** (0.40)	1.25*** (0.40)
Large matrilineal kin groups?							0.55 (0.40)	0.50 (0.40)	0.55 (0.41)	0.50 (0.41)
Large patrilineal kin groups?							1.70*** (0.42)	1.55*** (0.43)	1.63*** (0.43)	1.51*** (0.43)
Pseudo R-squared	0.04	0.09	0.05	0.11	0.10	0.14	0.24	0.26	0.28	0.29
Wald test	17***	32***	28***	45***	35***	52***	61***	67***	66***	71***
-2LogL	586	562	580	555	558	539	512	506	498	493

Table 5: Logistic models of whether a society has a fixed post-marital residence rule (yes=1) *(*** =99% sig., ** =95% sig., * =90% sig.)*

Variable description	*a.*	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*	*h.*	*i.*	*j.*
Intercept	0.21 (1.21)	-0.30 (1.26)	0.04 (1.22)	-0.31 (1.24)	-0.59 (1.29)	-1.09 (1.32)	0.14 (1.31)	0.004 (1.31)	-0.58 (1.38)	-0.80 (1.39)
Average temperature (degrees Fahrenheit)	0.02 (0.01)	0.02 (0.02)	0.02 (0.01)	0.01 (0.02)	0.02 (0.02)	0.02 (0.02)	0.01 (0.02)	0.01 (0.02)	0.02 (0.02)	0.01 (0.02)
Yearly temperature range	0.01 (0.01)	0.02 (0.01)	0.01 (0.01)	0.01 (0.01)	0.02* (0.01)	0.02 (0.01)	0.01 (0.01)	0.01 (0.01)	0.02 (0.02)	0.01 (0.02)
Reliance on ag./herding (0-100)			0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.02 (0.33)	0.005 (0.01)	0.004 (0.01)	0.01 (0.01)	0.01 (0.01)
Ag. technology level (0-2)			-0.16 (0.32)	-0.04 (0.31)	-0.14 (0.33)	0.02 (0.33)	0.12 (0.34)	0.17 (0.34)	0.14 (0.35)	0.21 (0.35)
Use of plow technology?		-1.39*** (0.53)			-1.65*** (0.57)	-1.84*** (0.60)			-1.84*** (0.65)	-1.97*** (0.66)
Use of metalworking?		1.29*** (0.49)			1.01*** (0.55)	0.80 (0.56)			0.87 (0.61)	0.75 (0.62)
Prob. of skilled labor market	-0.59 (0.49)	-0.68 (0.67)	-0.96* (0.54)	-1.13** (0.56)	-0.66 (0.70)	-0.54 (0.73)	-0.91 (0.57)	-0.98* (0.58)	-0.31 (0.75)	-0.23 (0.76)
Prob. of unskilled labor market	0.77 (0.51)	0.56 (0.54)	0.51 (0.53)	0.31 (0.54)	0.38 (0.55)	0.11 (0.57)	0.36 (0.55)	0.24 (0.56)	0.26 (0.58)	0.09 (0.59)
Transfers with marriage?				1.09*** (0.33)		1.12*** (0.35)		0.52 (0.35)		0.60 (0.37)
Small community units?							-0.68 (0.42)	-0.57 (0.44)	-0.52 (0.44)	-0.40 (0.45)
Large community units?							1.07* (0.58)	0.98* (0.59)	1.11* (0.59)	1.03* (0.59)
Large matrilineal kin groups?							0.75 (0.56)	0.74 (0.56)	0.75 (0.58)	0.70 (0.58)
Large patrilineal kin groups?							2.13*** (0.69)	2.02*** (0.70)	2.12*** (0.71)	2.01*** (0.71)
Pseudo R-squared	0.02	0.07	0.03	0.07	0.08	0.12	0.17	0.17	0.20	0.21
Wald test	5	14**	8	18***	16**	25***	26***	28***	31***	33***
-2LogL	291	279	288	296	277	267	254	252	244	242

Table 6: Logistic models of whether a society has a fixed post-marital residence rule (yes=1), sample weighted according to Murdock's clustering scheme (n=813) *(***=99% sig., **=95% sig., *=90% sig.)*

Variable description	*a.*	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*	*h.*	*i.*	*j.*
Intercept	1.03 (1.21)	0.65 (1.24)	0.93 (1.22)	0.55 (1.22)	0.51 (1.26)	0.03 (1.27)	0.54 (1.36)	0.40 (1.36)	-0.05 (1.42)	-0.23 (1.42)
Average temperature (degrees Fahrenheit)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.02)	0.02 (0.02)	0.01 (0.02)	0.01 (0.02)	0.01 (0.02)	0.02 (0.02)	0.01 (0.02)
Yearly temperature range	-0.001 (0.01)	0.004 (0.01)	0.001 (0.01)	0.001 (0.01)	0.01 (0.01)	0.01 (0.01)	-0.001 (0.01)	-0.001 (0.01)	0.004 (0.01)	0.004 (0.01)
Reliance on ag. herding (0-100)			0.02* (0.01)	0.01* (0.01)	0.02* (0.01)	0.02* (0.01)	0.01 (0.01)	0.01 (0.01)	0.02 (0.01)	0.02 (0.01)
Ag. technology level (0-2)			-0.48 (0.33)	-0.34 (0.33)	-0.47 (0.33)	-0.32 (0.33)	-0.26 (0.34)	-0.20 (0.35)	-0.25 (0.35)	-0.17 (0.35)
Use of plow technology?		-1.20** (0.53)			-1.36** (0.57)	-1.53*** (0.59)			-1.68*** (0.67)	-1.78*** (0.68)
Use of metalworking?		1.18*** (0.49)			0.98*** (0.55)	0.77 (0.57)			0.68 (0.62)	.057 (0.63)
Prob. of skilled labor market	-0.38 (0.50)	-0.51 (0.69)	-0.79 (0.54)	-0.98* (0.57)	-0.61 (0.72)	-0.52 (0.75)	-0.95 (0.59)		-0.26 (0.79)	-0.20 (0.80)
Prob. of unskilled labor market	0.93* (0.53)	0.74 (0.55)	0.65 (0.56)	0.46 (0.57)	0.53 (0.57)	0.27 (0.58)	0.54 (0.58)		0.45 (0.60)	0.30 (0.61)
Transfers with marriage?				1.04*** (0.33)		1.04*** (0.34)		0.45 (0.36)		0.52 (0.37)
Small community units?							-0.83* (0.42)	-0.75* (0.43)	-0.72* (0.43)	-0.63 (0.44)
Large community units?							1.81** (0.77)	1.73** (0.77)	1.87** (0.77)	1.79** (0.78)
Large matrilineal kin groups?							0.67 (0.58)	0.65 (0.58)	0.62 (0.59)	0.57 (0.59)
Large patrilineal kin groups?							1.77*** (0.64)	1.65** (0.65)	1.75*** (0.65)	1.62** (0.66)
Pseudo R-squared	0.03	0.07	0.05	0.09	0.09	0.13	0.22	0.22	0.25	0.25
Wald test	6	13**	10	19***	15*	23***	29***	30***	33***	35***
-2LogL	291	281	286	277	278	269	249	248	242	240

Table 7: Logistic models of whether a society has a fixed post-marital residence rule (yes=1), first cluster sample using Murdock's clustering scheme (n=383) *(***=99% sig., **=95% sig., *=90% sig.)*

Variable description	*a.*	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*	*h.*	*i.*	*j.*
Intercept	-0.39 (1.17)	-0.94 (1.23)	-0.45 (1.18)	-0.67 (1.21)	-1.06 (1.24)	-1.46 (1.29)	-0.31 (1.26)	-0.39 (1.28)	-0.98 (1.32)	-1.15 (1.34)
Average temperature (degrees Fahrenheit)	0.03** (0.01)	0.03** (0.01)	0.03** (0.01)	0.02 (0.02)	0.03** (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)
Yearly temperature range	0.02* (0.01)	0.02** (0.01)	0.02* (0.01)	0.02** (0.01)	0.02** (0.01)	0.02** (0.01)	0.01 (0.01)	0.01 (0.01)	0.02* (0.01)	0.02* (0.01)
Reliance on ag./herding (0-100)			0.01 (0.01)	0.002 (0.01)	0.01 (0.01)	0.003 (0.01)	-0.003 (0.01)	-0.004 (0.01)	-0.001 (0.01)	-0.002 (0.01)
Ag. technology level (0-2)			-0.03 (0.32)	0.07 (0.32)	-0.01 (0.33)	0.13 (0.33)	0.30 (0.35)	0.33 (0.34)	0.32 (0.35)	0.38 (0.35)
Use of plow technology?		-1.32*** (0.50)			-1.46*** (0.54)	-1.67*** (0.56)			-1.64*** (0.61)	-1.78*** (0.63)
Use of metalworking?		1.12** (0.47)			0.96* (0.52)	0.77 (0.54)			0.68 (0.58)	0.60 (0.59)
Prob. of skilled labor market	-0.77 (0.48)	-0.86 (0.64)	-0.94* (0.52)	-1.12** (0.54)	-0.81 (0.67)	-0.71 (0.70)	-1.01* (0.56)	-1.08* (0.57)	-0.48 (0.71)	-0.43 (0.72)
Prob. of unskilled labor market	0.65 (0.50)	0.50 (0.53)	0.50 (0.53)	0.37 (0.54)	0.42 (0.55)	0.22 (0.56)	0.46 (0.56)	0.38 (0.56)	0.33 (0.59)	0.21 (0.60)
Transfers with marriage?				1.10*** (0.33)		1.15*** (0.35)		0.47 (0.35)		0.60 (0.37)
Small community units?							-0.79* (0.43)	-0.68 (0.45)	-0.67 (0.45)	-0.54 (0.46)
Large community units?							0.80 (0.53)	0.72 (0.53)	0.83 (0.54)	0.75 (0.54)
Large matrilineal kin groups?							0.94* (0.57)	0.92 (0.57)	0.90 (0.58)	0.86 (0.58)
Large patrilineal kin groups?							2.49*** (0.76)	2.39*** (0.76)	2.48*** (0.77)	2.38*** (0.78)
Pseudo R-squared	0.03	0.08	0.04	0.09	0.08	0.13	0.21	0.22	0.25	0.26
Wald test	7	15**	8	18**	16**	25***	28***	30***	33***	35***
-2LogL	297	287	296	285	286	275	256	255	249	246

Table 8: Logistic models of whether a society has a fixed post-marital residence rule (yes=1), second cluster sample (n=382) *(***=99% sig., **=95% sig., *=90% sig.)*